# Nanomagnetism

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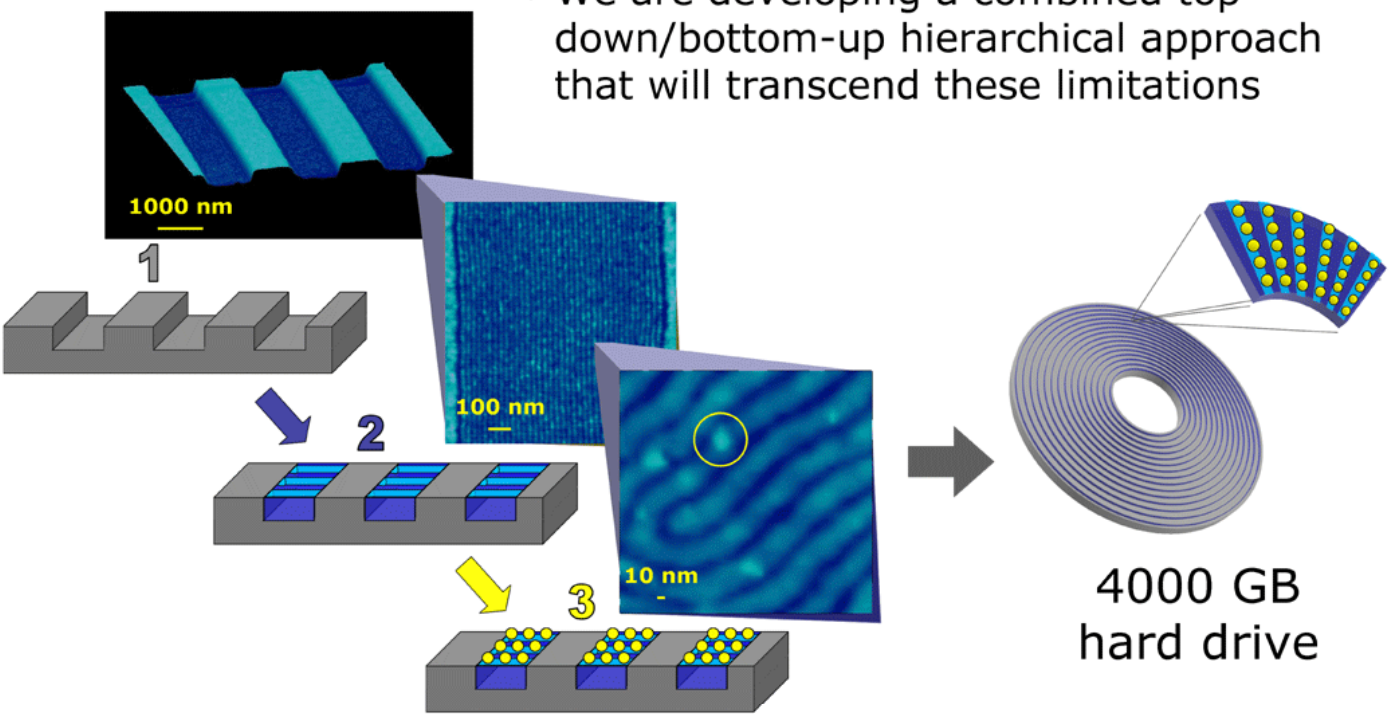
## Introduction

- Nanoscale magnetic systems display properties distinct from bulk materials
- Burgeoning industrial applications such as spintronics and magnetic recording demand a deeper understanding
- Preparation and characterization are ongoing challenges as traditional techniques run into intrinsic limitations

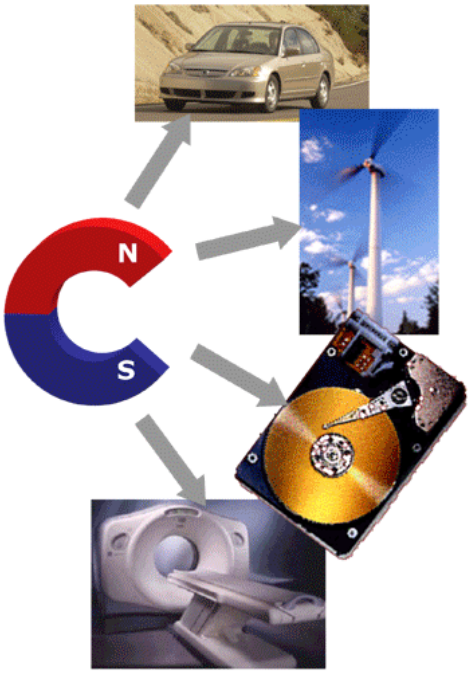
## Self-Assembling Data Storage

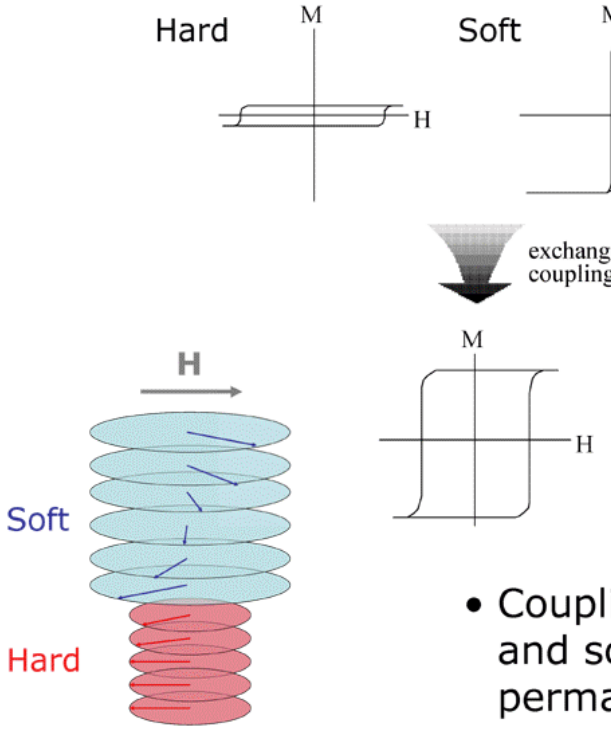
- Hard drive capacities have been growing exponentially for decades, but current "top-down" technology will soon hit fundamental limits
- We are developing a combined top-down/bottom-up hierarchical approach that will transcend these limitations



# Stronger Magnets to Save Energy

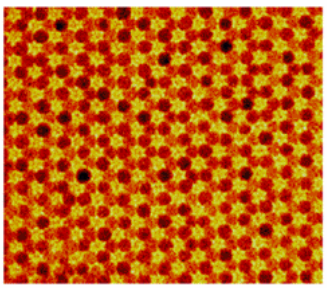
- Permanent magnets are widely used in a variety of industries and products, such as electrical motors



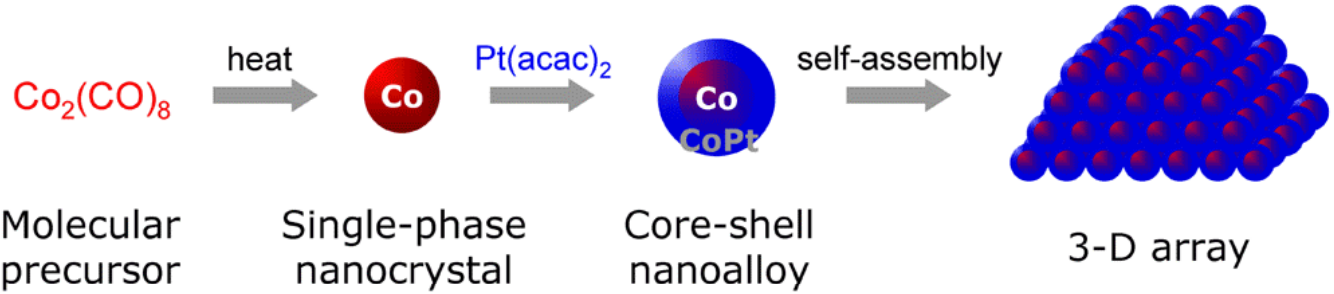




- Coupling the characteristics of hard and soft magnets leads to stronger permanent magnets—stronger magnets save energy

- The challenge is to limit the size of the soft phase to suppress a twisted spin structure



- Core-shell nanoparticles are the ultimate exchange-spring magnet with exquisite control of particle size



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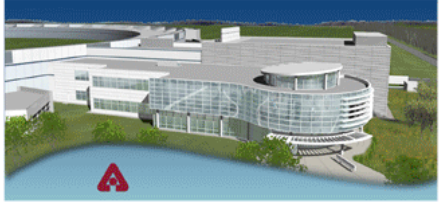
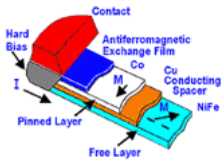
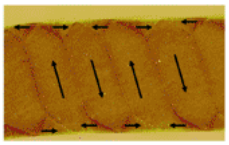
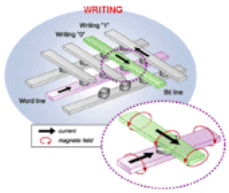
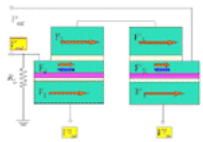
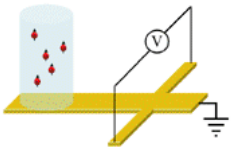
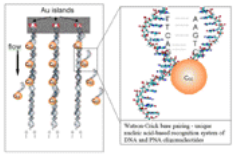


# Spintronics: Next-Generation Devices

- Combining spin and charge in electronics promises energy-efficient devices

| Applications | | Research | |
|---|---|---|---|
|   | Read heads |  | Current-induced magnetization changes |
|   | Magnetic RAM |  | Lateral magnetotransport |
|  | New logic |   | Magnetotransport in nonmagnetic materials |
|  | Quantum computers |   | Qubit networks |

# Future Impact